FACTS
(Reprinted from "LEGACY", Vol. 12 No. 3)

Ontario
Ministry of the Environment
Hon. Andrew S. Brandt Minister
Brock A. Smith Deputy Minister

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About the History of Water Treatment

Ontario's quest for clean water

by Robert Koci and Denise Munchee

Although more than three years have passed since the United Nations declared the Eighties as the World Water and Sanitation Decade, little attention has been paid in Ontario to this international effort to provide abundant clean water to the world's peoples.

The main reason for this lack of interest is that the 98 per cent of Ontario's inhabitants who receive all the water they want at the turn of a tap, simply take their supply for granted.

According to a recent report of the World Health Organization, diseases associated with dirty water kill 50,000 people every day — or more than 18 million people a year. In Ontario, no death has been associated with waterborne disease epidemics for at least 20 years.

Even in this province, blessed by access to about one fifth of the world's fresh water supply, it has not always been so.

Outhouse, well, pigsty and the site on which most of the kitchen slop was disposed of were often kept close together for convenience.

The first settlers arriving 200 years ago in what is now Ontario had it easy. The land grants they received generally included a stretch of shore on a watercourse, and water was readily available.

Some farmers built wharves extending out into the stream to reach clear, running water. "Any one who has been in the habit of drinking this water can never forget its peculiar flavor, although it tastes good when you are thirsty", writes a "Canuck" in a book on Early Pioneer Life in Upper Canada about the Niagara River water.

Why the water should have a peculiar flavor is not very clear. Before the arrival of the first settlers the land has been occupied only sparsely by nomadic or semi-nomadic Indian tribes, and the water was free of industrial or other unhealthy effluents.

The later arrivals found most shores occupied and resorted to the abundant groundwater supply. To reach it they dug wells, generally to a depth of six to eight metres (20 to 25 feet).

The first pumps were made by boring lengthwise through a tamarac or pine log. A rod ran through the hollowed out log at the lower end of which was a sucker made of leather with a valve which allowed the water to flow through when the plunger was lowered and which closed as the plunger was brought up.

A curbing or box arrangement was put around the top to prevent anyone from falling in. A pole with a crock at one end for hanging a pail on was used to get at the water. Deeper wells had a rope and windlass system for drawing up water.

Another means of drawing water was called a "sweep". It consisted of a long pole with a heavy end fitted in a post with a crotch. The light, longer end had a pole attached to it long enough to reach to the water in the well. On the end of the pole hung the bucket.

Another common pump system was the chain pump. In it a chain is run through a pipe and water is brought up by "buttons" placed at intervals along the chain.

The water, however, was not always as clean as it could have been. There was no public health officer around to test its quality, and the "flux" was a very common illness. The reasons are evident from a description of the life of Dirk McQuinn's farm in Bruce County: "The well was usually close to the house, for convenience, as were the barnyard, the chicken coop, the pig sty and the privvy..."

The description of McQuinn's farm dates from about 1870, but the conditions applied to many settlements throughout the 19th century.

The first piped water supply in Ontario was established in 1837 in Toronto as a private operation by Albert Furniss. The water was pumped without treatment from Lake Ontario.

A homemade pump made by boring out a pine log — and its proud constructor and owner. The photo was taken about 1880 and has been provided from the large collection of historical documents collected by Dave Thomas, water works supervisor in Parry Sound.

The system's main task was to provide water for fire-fighting. By 1856 only 11 per cent of all houses in Toronto were drawing Furniss's water for domestic use, and many users complained frequently about it.

That the taste and smell of water can be improved has been well known since the dawn of civilization. A collection of East Indian medical lore from about the year 2000 BC recommends keeping water in copper vessels, exposing it to sunlight and filtering it through charcoal or sand and coarse gravel.

Egyptians, Greeks and Romans used settling ponds and added lime or aluminous earth as precipitants and filtered water through earthenware jars. Roman emperor Nero believed that water was more wholesome when it was boiled.

It wasn't until the 1850s that scientists began to suspect that water might carry disease. The suspicion arose in Britain after an epidemic of cholera that claimed nearly 250,000 lives between 1845 and 1849. In 1853 the disease swept the London area again, claiming 11,000 lives. An investigation traced the first 69 deaths to a public supply well. A pipe draining a cesspool into the well was found to be the source of the contamination.

Knowledge, however, spread slowly. The water supply system built in Kingston in 1849 was the first in Ontario to be equipped with a filter at the intake crib. An epidemic of cholera and a rash of fires in Hamilton in 1854 led to the construction of water works with an improved filtering system.

Municipalities at that time were not compelled by law to provide a water supply and usually deferred action until forced by a disaster.

In 1873 the municipality of Toronto took over the operation of the water supply from Mr. Furniss, expanded the distribution system to serve more houses, built the Rosehill reservoir and added to the John Street pumping station.

Toronto's example was followed by other communities in Ontario, and the construction of urban water works increased markedly between 1870 and 1879. By the turn of the century there were 110 water supply systems in operation. Of these, 66 were run by municipalities.

In Toronto, improvements to the water supply became of special interest to the citizen after the great fire of 1904, and ratepayers authorized $1 million for improvements. In 1909 slow sand filtration and electric pumps were installed at the Toronto Island waterworks. Chlorination, started in 1910, resulted in an immediate drastic reduction of typhoid fever, tuberculosis and infant mortality.

Since then the capacity of the Toronto waterworks has grown nearly 500-fold from 181,000 cubic metres (40 million Imperial gallons) per day to 2.2 million cubic metres (nearly 480 million Imperial gallons) per day in 1983.

In 1916 the federal Commission of Conservation detailed in its report, Water Works and Sewerage Systems in Canada, the installation of every existing water system in the country. A random selection from the report illustrates the rapid development of water supply systems during the late 19th century:

St. Catharines built a municipally-owned water works in 1879. The supply was by gravity from Lake Erie via the Welland Canal, and the water was purified by sedimentation and liquid chlorine treatment. The annual flat rate for water supply was $3.50 to $6 per dwelling, with an extra $5 for a bathroom — if there was one. A metered rate was also available — 5 to 19 cents per 1,000 gallons.

The Ottawa system started up in 1874 and used the Ottawa River as its source. In the same year, Uxbridge, north of Toronto, installed a water supply for fire protection only. Insurance rates were much lower in communities with a piped water supply.

The London system started operation in 1878 and that in Guelph in 1879. The Sault Ste. Marie water works started operation in 1894, the one in Fort William — now part of Thunder Bay — in 1908. The annual cost for this supply was a flat rate of $8 to $14 per dwelling with an extra $6 to $10 for a bathroom.

The construction of waterworks and distribution systems solved some, but not all the problems. Frequently untreated sewage outlets and water intakes were placed close together and the result was a contaminated water supply. In Sarnia, for example, the sewage outfall and the drinking water intake were only 45 meters (150 feet) apart.

Such weakness of the systems showed up in Ottawa. The population of the city grew by 20,000 between 1905 and 1910. During the same period, 133 typhoid deaths were reported. In 1911 and 1912 Ottawa suffered especially severe outbreaks of typhoid, with 1,378 deaths in 1912 alone.

1,378 typhoid deaths in 1912 in Ottawa

The epidemics were attributed to the decay of the city's piping; broken pipes allowed sewage and drinking water to mix.

Despite such setbacks, there was some progress. In 1882, the year of the formation of the Provincial Board of Health, 180 of every 100,000 people died of typhoid or similar diseases. Between 1903 and 1913 the typhoid death rate decreased to 24.4 per 100,000.

The improvement was the result of the work of a few devoted civil engineers whose achievements are generally overlooked in the annals of history. During the second half of the 19th century the most outstanding among them was Thomas Keefer.

Mr. Keefer constructed the Montreal water supply system in 1853 and the project became so successful that he was asked, during the next 25 years, to work as a consultant on water supply projects in many cities, among them Toronto, St. Catharines, Hamilton, Ottawa and London.

By 1915 Ontario led all other Canadian provinces in the amount spent for communal water systems as well as in the total amount of pipe laid. By then, the province had spent $44.5 million (in 1916 dollars) for such projects, and had laid 4,253 km (2,643 miles) of mains which supplied, on the average, 527 litres (116 gallons) of water to each individual using the system. A total of 166 plants were in operation, of which 146 were run by municipalities and 20 by private companies.

improvements after World War I

Filtering and other treatment was, however, provided only in 37 water supply systems. For the operation of pumps, steam and electric power were generally used, although one plant used wind power to pump water to households.

The real improvements, however, had to wait for the decade after World War I, the 1920s, and these improvements were the work of two outstanding Canadian civil engineers, Willis Chipman and Dr. Albert Berry.

Willis Chipman studied sewage and water works in the U.S., Scotland and England and became, after 1901, responsible for the design of more than 50 water and sewage works in Canada.

Thomas Coltrin Keefer (1821-1915) was one of Canada's leading hydraulic engineers of his time. The photo, taken in 1863, was adorned with sketches of Mr. Keefer's work. The numerous water works he built in many Ontario cities, however, are represented only by the drawing of a hydrant — quite appropriately, as at the time water works were primarily designed for fire protection.

Dr. Berry was a visionary in the field of sanitation. He joined Ontario's Provincial Board of Health in 1920 and was the first to realize that to reduce the incidence of typhoid, bacteria had to be killed by chlorination of sewage and of the water supply.

Dr. Berry's vision also included the destruction of bacteria in milk by pasteurization. Through his efforts, Ontario became a world leader in the implementation of chlorination of water and pasteurization of milk.

The responsibility for ensuring safe drinking water was the mandate of the Provincial Board of Health. The board had to approve all municipal plans for water supply and sewage treatment systems.

In 1924 it was given full status as the Department of Health, and Dr. Berry was appointed, in 1926, director of the department's division of sanitary engineering. In this position he investigated a number of epidemics including TB, typhoid and paratyphoid.

in 1930 — 237 municipalities had water works

Up to the first decade of the 20th century, all municipalities on the shores of the Great Lakes used them as a giant depository for all their sewage. The International Joint Commission, established in 1909, found after an extensive study that all municipal water supplies taken from the Great Lakes were unsafe to drink.

In keeping with the ideas of Dr. Berry, the IJC reports recommended:

No complaints

When property owners complain about the water bill, David Thomas, waterworks supervisor in Parry Sound, has a good answer: "There is plenty of water around," he tells the complainant. "I will cut your water supply off and lend you these two pails for a month, free of charge. If, after a month, you still sincerely believe that the rate is too high, I will supply you water free for the rest of your life."

Since David started to work at the Parry Sound waterworks some 40 years ago, nobody has taken up his offer.

Dr. Albert Berry stood for many years in the forefront of Ontario's quest for pure drinking water. The photo was taken in 1983 at Dr. Berry's home in St. Marys, Ont. (photo: R. Koci)

— a daily bacteriological examination of drinking water

— the treatment of all water supplies

— the installation of proper sewage treatment.

By 1930, 70 Ontario municipalities had sewage treatment plants and 237 municipalities had water works. The quality of the distributed water, however, varied widely.

In the following depression years construction of new systems ground to a halt, and few municipalities had the financial means to maintain water and sewage systems properly. What public money there was was spent on alleviating social problems.

During these years, Ontario's urban centres also experienced a constant growth, and sanitation and water supply systems did not keep pace with this development. The existing systems became not only outdated, but also overloaded, especially as the onset of World War II and the booming production of materials used by the Allied forces brought a new source of contamination onto the scene: industrial waste.

The provincial government tried to help in 1943 by an amendment of the Municipal Act to allow municipalities to finance water projects by user rates rather than from general taxes.

In 1950, the newly formed Municipal Improvement Corporation provided to municipalities money for sanitary works at low interest rates. During the late Forties the addition of fluorides to drinking water for the prevention of dental caries was much discussed and as a result several water supply systems adopted fluoridation as an additional service.

By 1950 the typhoid death rate had decreased to 0.02 per 100,000 population. But another study undertaken by the IJC between 1946 and 1949 revealed a three- to four-fold increase in bacteria levels since 1912 in some areas of the Great Lakes.

The oxygen demand of these industrial wastes was at the time estimated greater than the oxygen demand of the sewage produced by the 3.5 million people living in the study area.

To control the problem, Premier

OWRC established in 1956

Leslie Frost established the Ontario Water Resources Commission in 1956. The commission's mandate was:

— to build, finance and operate water treatment and sewage disposal systems, and

— to supervise and control the use of the province's water resources.

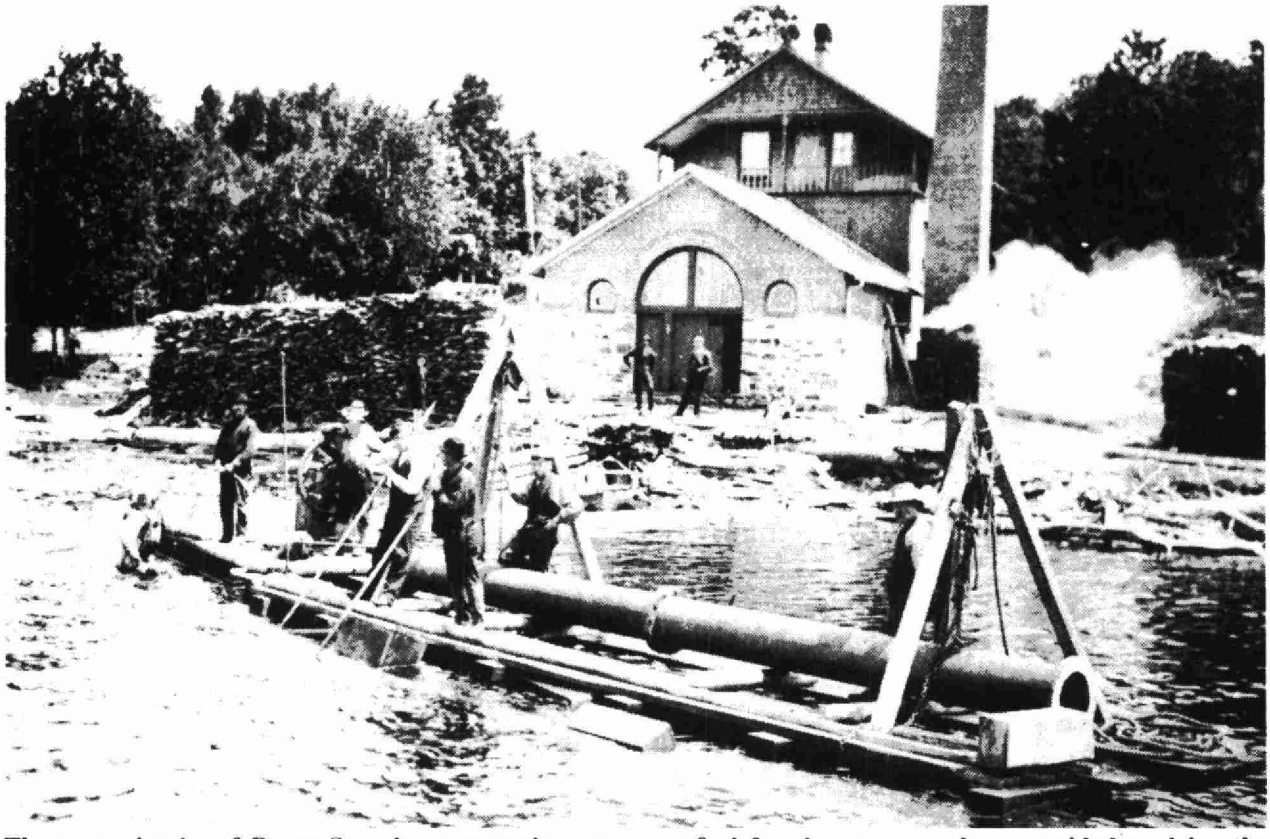
The work of the commission brought a vast improvement in Ontario's water works. With Dr. Berry as chief engineer and general manager from 1956 to his retirement in 1963, the number of water works and sewage works in the province increased steadily and the quality of sewage and water treatment improved dramatically.

The value of certificates of approval issued yearly by the OWRC for improvements and extensions of existing water works and for the construction of new ones increased steadily from $38.5 million in 1958 to $77.6 million in 1972. The OWRC

financial help to municipalities

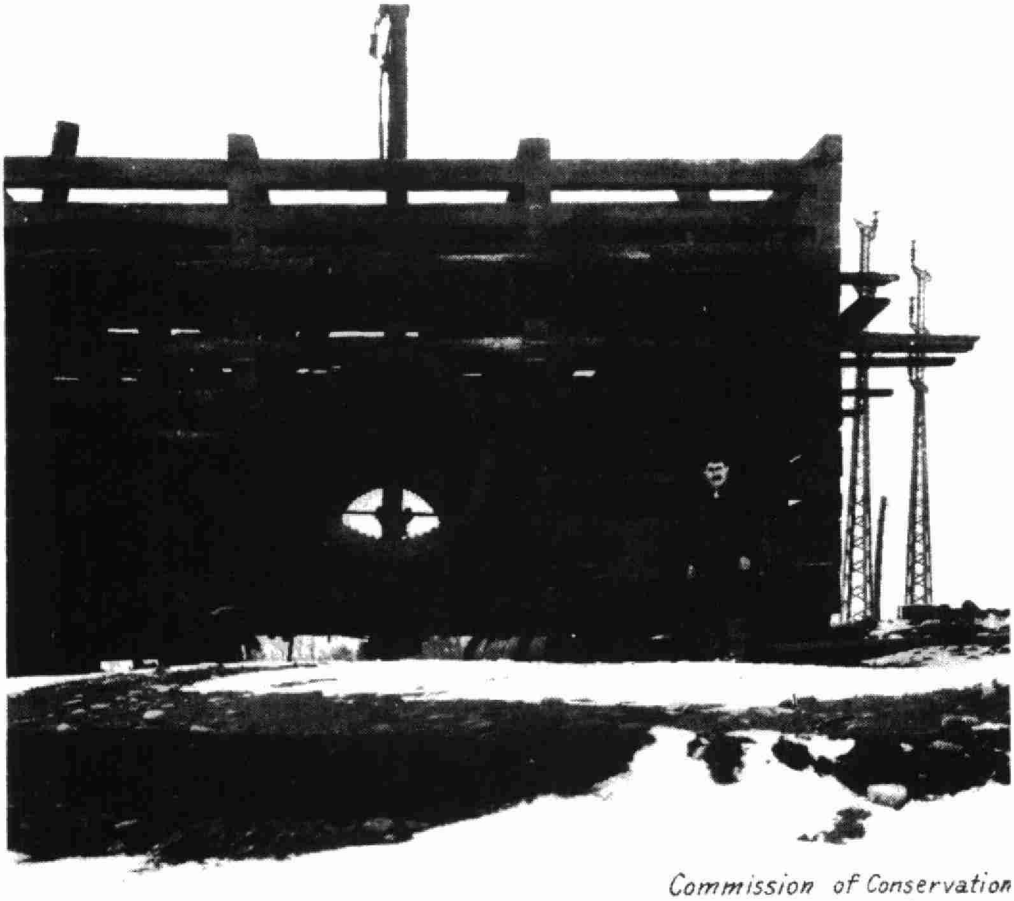
provided design, construction, financing and, if required, operators for these projects.

From 1969 on, the Ontario Government provided financial assistance to municipalities for water works projects. At the same time projects were encouraged that involved, where



The water intake of Parry Sound water works was placed in 1893. Note the staples of firewood to be used as fuel for the steam engines provided to drive the pumps. (Photo from the collection of Dave Thomas.)

Interior of the filter of the Toronto water filtration plant built in 1911. The photo shows the under drains and the first layer of gravel used as filtration medium.



Commission of Conservation

The crib at the end of the 48-inch water intake pipe of the Hamilton water works before placement into Lake Ontario in 1910.

possible, the supply of treated water from central works to several municipalities in the area.

The largest of these was the South Peel water supply system covering five municipalities serving 200,000 people with 218,000 cubic metres per day (48 million Imperial gallons per day).

In 1972 there were 455 public water supply systems operating in Ontario, 70 of which were operated by the province.

In 1972 the mandate of the OWRC was transferred to the newly formed Ontario Ministry of the Environment, and reconstruction, expansion and improvement of the province's water supply systems continued unabated.

The ministry's annual expenditure for water supply projects grew from $26 million in 1972/73 to $50 million in 1978/79. Since that year, however, the ministry's total annual expenditures for waterworks show a marked decline to $16.6 million in 1981/82, principally because by that time water systems were well established in all major municipalities and new construction and improvements were extended to smaller communities.

From 1956 to the end of the fiscal year 1982/83, a total of $2.043 billion was spent by federal, provincial and municipal agencies, according to Statistics Canada figures, to provide 98 per cent of Ontario's urban population with an abundant supply of clean water.

And the quest for a reliable, safe and abundant supply of drinking water for everybody in Ontario goes on.

The increased ability of analysts to detect minute quantities of pollutants in water goes hand in hand with Environment Ontario's continuous revisions and updating of water quality standards. The most recent edition of Ontario's drinking water objectives issued in the fall of 1983 lists over 50 water quality parameters of concern — among them exotic and suspected organics and inorganics and radiological, microbiological, physical and process parameters that may have an impact on health or esthetic considerations.

Average consumption: 450 lpd

When Environment Ontario engineers get involved in the design of a water treatment plant, they calculate the capacity of the plant on the basis of an averge consumption of 450 litres (100 gallons) per inhabitant of the community per day. This basic figure includes the average Ontarian's daily need for drinking, bathing, flushing, laundry, car washing, garden watering etc. At most, 10 litres of this are used for drinking.

The 100 gallon per day per inhabitant figure is generally modified by a variety of factors, among them the total population of the community, the presence of industry and the need for fire protection. In many of the world's developing countries, the availability of 450 litres of clean, treated water per person per day is an unattainable dream. This amount would be sufficient to keep an individual, for example, in the Sahel desert in Africa alive, healthy and active for more than half a year.

In addition to the Ontario Drinking Water Objectives, the ministry has developed an interim "priority list" of hazardous contaminants in drinking water and is employing this list in monitoring programs at priority locations.

In the summer of 1983 a dioxin/furan Drinking Water Assessment Program was established, in which 15 water works in the Central and West Central regions were assessed. Minute traces of low-toxicity dioxins were detected in raw water at the Lakeview and St. Catharines plant intakes, but none have been detected in treated water.

Eventually drinking water quality in major Ontario water works will be assessed in terms of the objectives and the "priority list" in a recently started long-term comprehensive monitoring program.

The ministry is also developing techniques that would allow the removal of hazardous contaminants during water treatment, whenever such removal is required. In a $1-

international cooperation sought

million project, the use of granular activated carbon in water filtration is being evaluated at the Niagara Falls water treatment plant.

The ministry is also discussing with the federal Department of Health and Welfare the possible enactment of a National Safe Drinking Water Act, a legislation that may have far reaching implications for the Ontario Drinking Water Program.

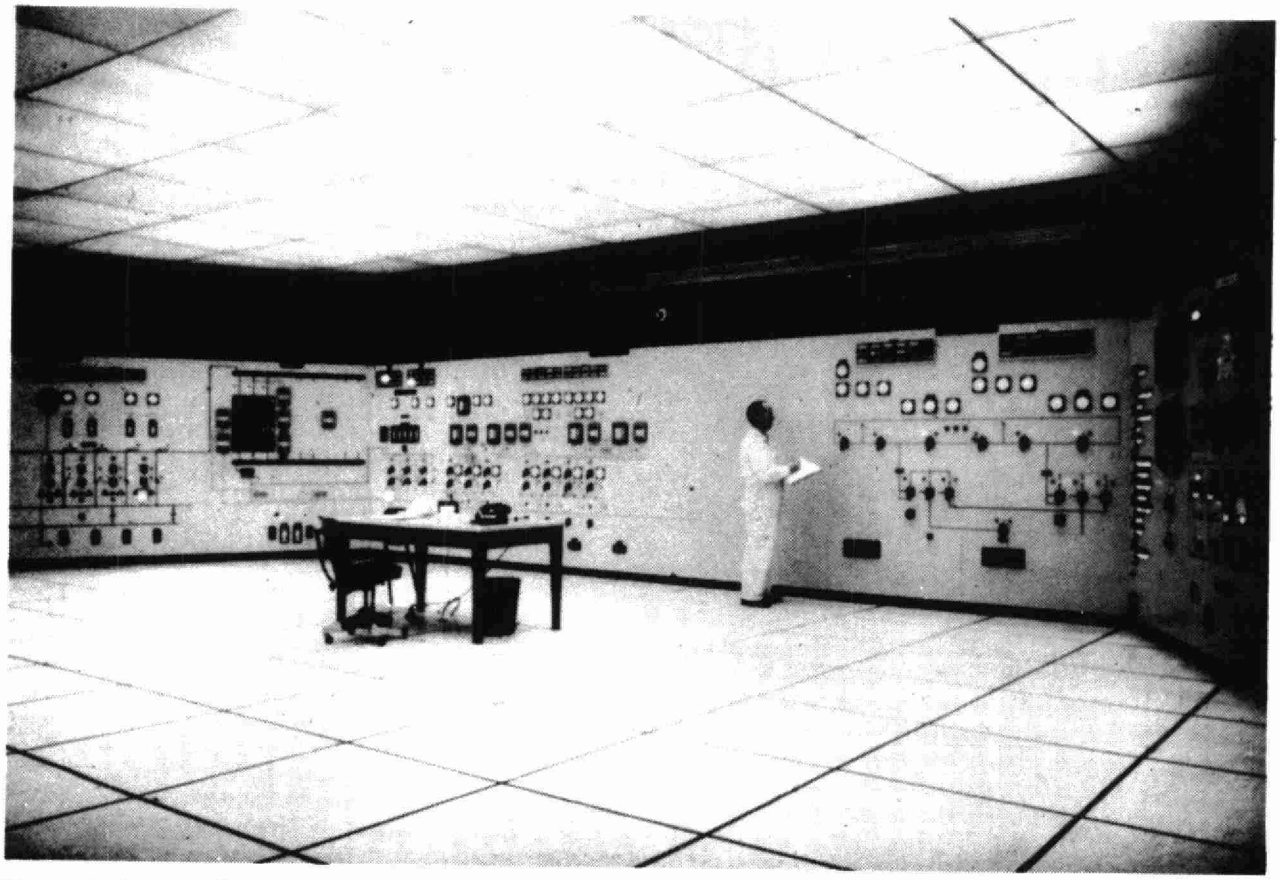
On the international field, Environment Ontario is proposing an international study designed to evaluate Great Lakes water quality as a source of drinking water. Such a study would assemble information on jurisdiction, treatment and monitoring requirements, collect U.S. and Canadian data on levels of contaminants, evaluate the validity of the data, examine the impact of water treatment technologies, compare data with existing and proposed drinking water standards and evaluate human health implications.

Toronto analyzes 1000 samples

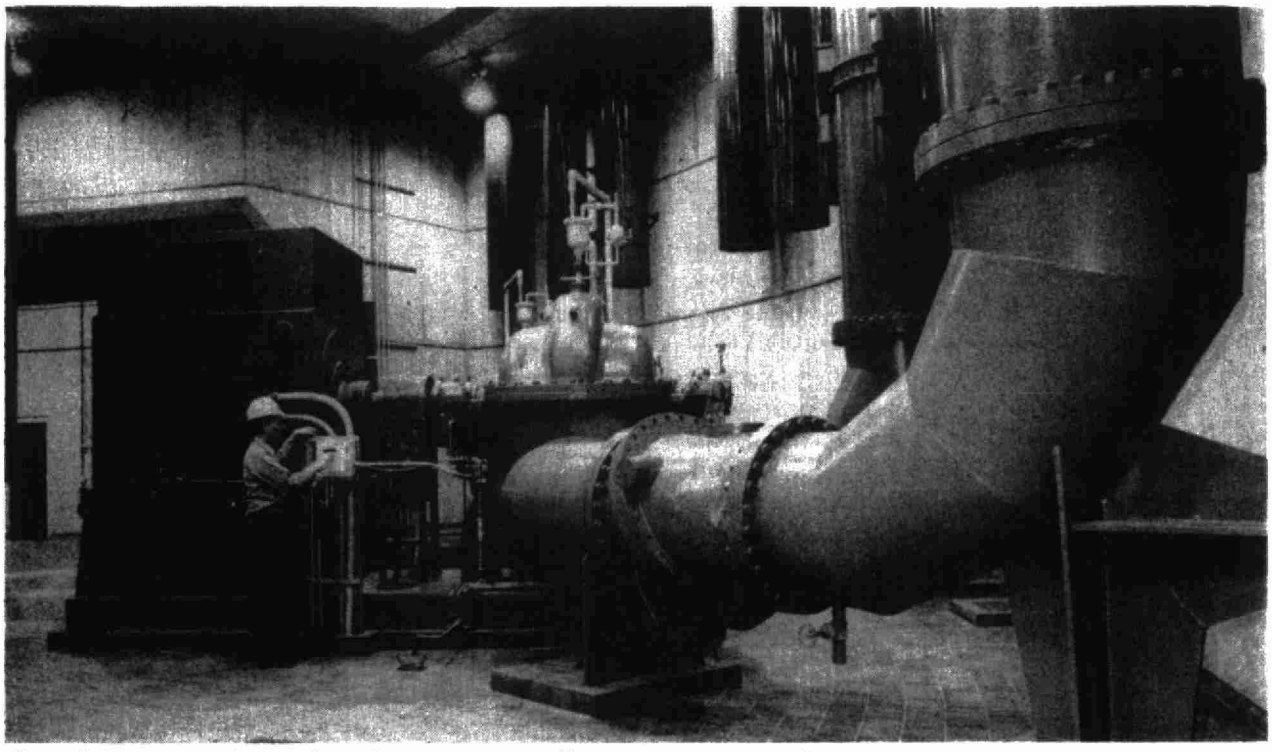
Aside from a ministry monitoring program involving all water supply systems, major water works are continuously monitoring the quality of their water output. The Toronto water works, for example, analyzes nearly 1,000 samples daily at its various plants and stations.

The best indication of the high quality of Ontario's drinking water remains the health of the population. All epidemiological and health statistics indicate that during the past decades overall health in the province has improved markedly, that epidemics caused by waterborne disease carriers are practically unknown, that stomach cancers — the cancer most likely to be caused by pollutants in water — have dramatically decreased while life expectancy shows a continuous upward trend.

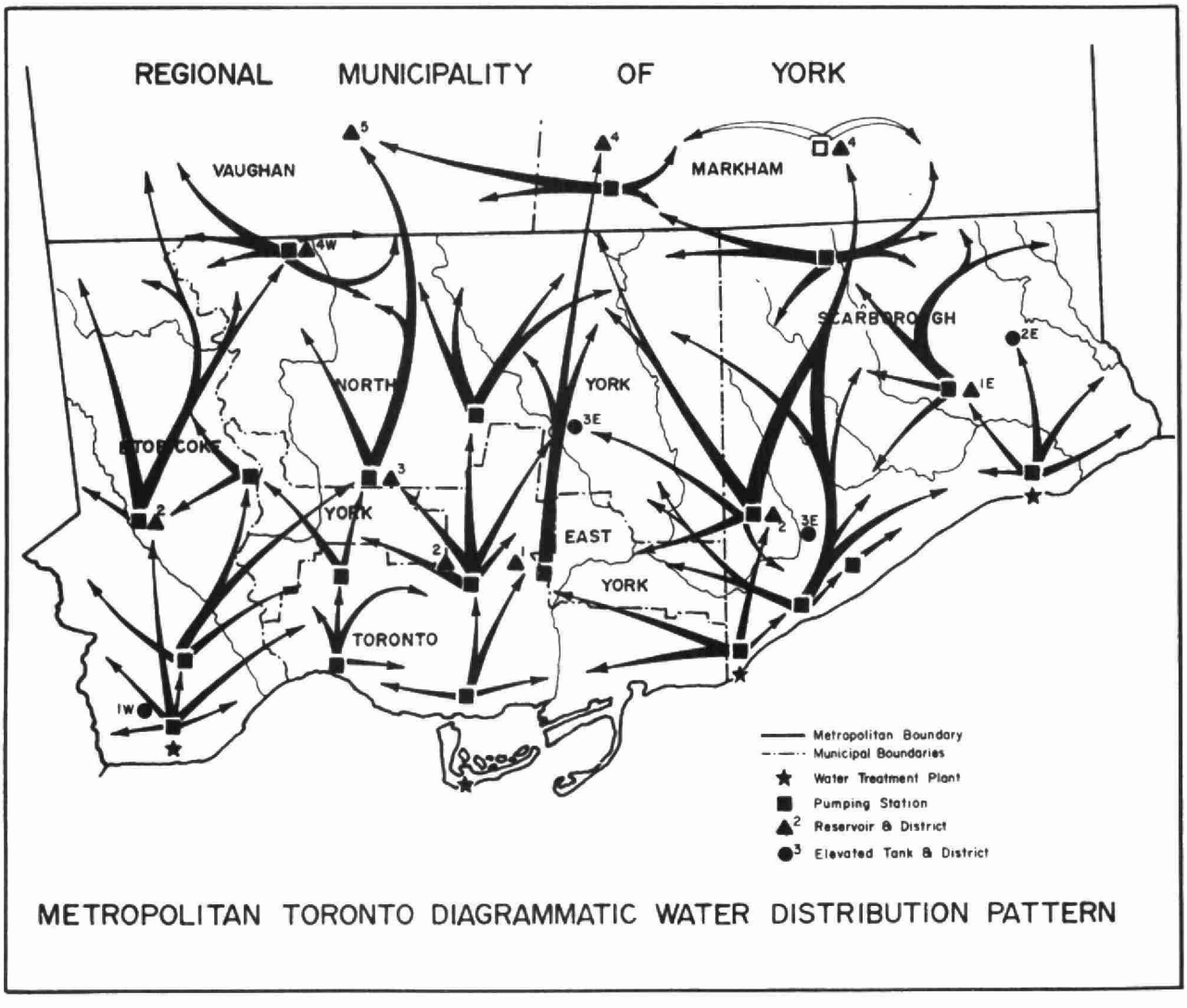
Environment Ontario's continuous concern, its close co-operation with other provincial, federal and international agencies and organizations involved in drinking water research, are the best guarantee that drinking water in Ontario will keep its exceptional quality. ◇



The control room of one of Toronto's water treatment plants in 1983. (photo: Metro Toronto Department of Works)



One of the large volume pipes that carry water from Lake Ontario to filtration in one of Toronto's water treatment plants.
(photo: Metro Toronto Department of Works)



METROPOLITAN TORONTO DIAGRAMMATIC WATER DISTRIBUTION PATTERN

(photo: Tessa Buchan)

Water quality is constantly monitored at all Ontario water works or at Environment Ontario's laboratories. Orlynn Rein is testing water samples for their oxygen level at the ministry's main laboratory.

First Print: June 1984